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Decontamination process development for gravels contaminated with uranium

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1. Introduction

Soil with a size of less than 10cm was usually a decontaminated using soil washing and electrokinetic technologies. It is difficult to apply soil washing technology for the decontamination of gravels larger than10 cm in size. It is impossible to scrub gravels in a washing tank, because gravels sinks to the bottom of the washing tank. In addition, when electrokinetic decontamination technology is applied to gravels larger than 10 cm, the removal efficiency of uranium from the gravels is reduced, because electro-osmotic flux at the surface of the gravel in electrokinetic cell reduces owing to a reduction of the particle surface area attributable to large-sized gravel. The volume ratio of gravel larger than10cm in total volume of the soil in KAERI was about 20%. Therefore, it is necessary to study the decontamination process of gravels contaminated with radionuclides.

2. Methods and Results

Washing technology is generally used for the decontamination of contaminated gravels. Gravel washing equipment was manufactured to wash the contaminated gravel, as shown in Fig.1. The removal efficiency based on the gravel size and weight was investigated using manufactured gravel washing equipment, as shown in Table1.

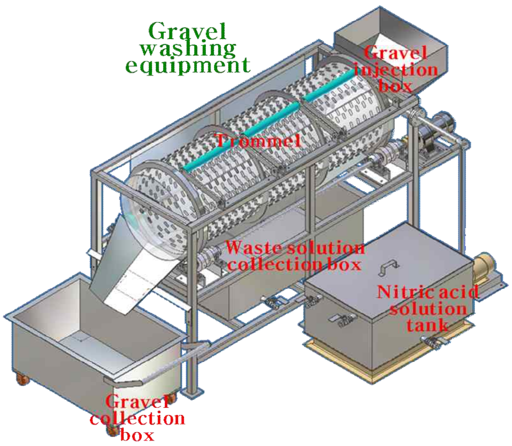

Fig. 1. Manufactured gravel washing equipment

Table 1. Removal efficiency based on the gravel size using gravel washing

Gravel size	Ci (Bq/g)	1st	2nd
5cm (154g)	2.25	1.04	1.01
5cm (266g)	2.93	2.14	2.10
10cm (766g)	2.54	1.83	1.76
10cm (784g)	2.12	1.67	1.61
15cm (944g)	1.9	1.32	1.27
15cm (1074g)	1.2	0.68	0.67
Average	2.16	1.45	1.40

Table 1 shows the results of the removal efficiency based on the gravel size from washing using the manufactured gravel washing equipment. The larger the gravel size, the more the contaminated concentration of gravel is reduced. The average concentration of gravel after the first washing was about 1.45 Bq/g. An average removal efficiency of gravel after the third washing was about 37% and the removal efficiency of the third gravel washing was very little in comparison those of the first and second washings. In addition, the removal efficiency of the contaminated gravel was not related to its size.

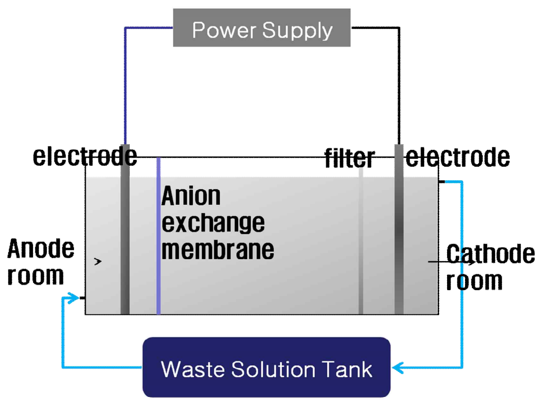

Fig. 2. Schematic diagram of electrokinetic-electrodialytic decontamination

The results of gravel washing showed a low removal efficiency of uranium from gravels. When electrokinetic decontamination technology is applied to gravels, the removal efficiency of radionuclides from gravel is reduced, because the electro-osmotic flux at the surface of gravel in the electrokinetic cell reduces owing to a large size of the gravel. Meanwhile, the electrodialytic method was generally used for treatment of the waste solution and soil remediation, and attaches an ion exchange membrane at the anode or cathode room, as shown in Fig.2.

The electrokinetic-electrodialytic experiment conditions are as follows. The gravel volume in the gravel cell was 400 L, the electric current was 150-200A, the electric voltage was 15-20 V, the electrolyte inflow rate was 130-160 ml/min, the temperature in the electrokinetic-electrodialytic experiment was below 65 °C, and L(electrolyte volume, ml)/S(gravel weight, g) in gravel cell was about 0.33. Table 2 shows the removal efficiency based on the decontamination period using electrokinetic-electrodialtic equipment. for a decontamination period of 5 days, 10 days, 15 days, and 20 days, ^{238}U in gravel was removed by about 42%, 64%, 74%, and 80%, respectively. The more the decontamination time elapsed, the more the removal efficiency ratio of ^{238}U reduced. In addition, the more the initial concentration of ^{238}U increased, the more the removal efficiency of ^{238}U increased.

Table 2. Removal efficiency based on the decontamination period by electrokinetic-electrodialtic equipment

Period	0rigin Bq/g	5 days	10 days	15 days	20 days (Bq/g)
Removal Efficiency	1.7	43%	65%	74%	81% (0.32)
Removal Efficiency	1.3	41%	63%	73%	79% (0.27)

The decontamination process for gravels was generated on the basis of the results of washing and electrokinetic-electrodialtic experiments, as shown in Fig. 3.

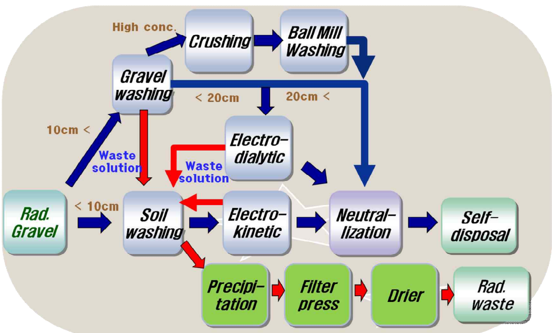

Fig. 3. Decontamination process for gravels contaminated with uranium

3. Conclusions

. The optimum number of washings for contaminated gravels is considered to be two. In addition, the removal efficiency of contaminated gravel was not related to its weight. For an electrokinetic-electrodialytic decontamination period of 5 days, 10 days, 15 days, and 20 days, ^{238}U in gravel was removed by about 42%, 64%, 74%, and 80%, respectively. The more the decontamination time elapsed, the greater the reduction of the removal efficiency ratio of ^{238}U. The decontamination process for gravels was generated on the basis of the results of washing and electrokinetic-electrodialtic experiments.

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